OFFICIAL STUDY TITLE

The Effect of Land and Water Exercises on Recreational Swimming Behaviors and Physical Performance in Older Adults

NCT NUMBER Pending

UNIQUE PROTOCOL ID EskisehirTU-SBF-CK-03

DOCUMENT DATE January 15, 2025

DOCUMENT TYPE Study Protocol and Statistical Analysis Plan (SAP)

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SECTION 1: STUDY PROTOCOL & DESIGN

1.1 Background & Rational

Aging is associated with progressive declines in muscle strength, functional endurance, and balance, leading to heightened risks of sarcopenia, frailty, and accidental falls. Aquatic environments offer unique buoyancy and resistance properties that facilitate joint-friendly neuromuscular training. Combined land and water exercise protocols leverage ground-reaction forces on sand and fluid resistance in shallow sea water, potentially maximizing functional gains while improving water safety awareness and reducing fall-related anxiety in older adults.

1.2 Study Aim & Objectives

The primary objective of this study is to evaluate the effects of an 8-week structured land and aquatic exercise program on functional upper and lower extremity muscle strength, recreational swimming behaviors, and perceived fall anxiety during water entry/exit among older adults residing in a coastal resort region.

1.3 Study Design & Setting

This study employs a single-arm, quasi-experimental pre-test/post-test clinical design. The trial was conducted between June 21 and August 31, 2025, in the coastal resort area of Altinova (Ayvalik district, Balikesir province, Turkiye).

1.4 Participant Eligibility

Inclusion Criteria:

- Age between 62 and 86 years.
- Residing in or visiting the Alt⸝nova/Ayval⸝k coastal resort area during the intervention period.
- Ability to independently perform Activities of Daily Living (ADL).
- Willingness to voluntarily participate and sign a written informed consent document.

Exclusion Criteria:

- Participation in regular structured exercise routines within the preceding 12 months.
- Severe cardiovascular, neurological, cognitive, or musculoskeletal disorders contraindicating exercise.
- Acute medical conditions restricting immersion in sea water or physical performance testing.

1.5 Intervention Protocol

Participants engaged in an 8-week, 24-session exercise intervention delivered 3 times per week (30 minutes per session). Training occurred on sand/beach terrain and in shallow sea water (waist-deep). Each session comprised three structured components:

Component	Duration	Location	Specific Content & Drills
Warm-up	5 minutes	Sand / Shoreline	Brisk walking on loose sand, dynamic joint mobilization (ankle, knee, hip, shoulder circles).
Main Exercise Module	20 minutes	Sand & Waist-Deep Water	Land/Sand: Bodyweight squats, knee push-ups, forward/lateral sand walking.
Component	**Duration**	**Location**	**Specific Content & Drills**
			Aquatic: High-knee marching against water drag, multi-directional arm flexions/extensions, aquatic balance drills.
Cool-down & Routine	5 minutes	Shallow Water & Shore	Controlled water entry/exit practice, static stretching for major muscle groups on land.

1.6 Outcome Measures

Primary Outcomes:

Lower Extremity Muscle Strength: Evaluated using the 30-Second Chair Stand Test (30CST). Recorded as total completed repetitions in 30 seconds. Tested at Baseline and Week 8.

Upper Extremity Muscle Strength: Measured in kilograms (kg) via a Jamar hydraulic hand dynamometer (dominant hand). Maximum score of two trials recorded. Tested at Baseline and Week 8.

Secondary Outcomes:

Swimming Behaviors Score: Measured via a 4-item continuous index adapted from Moran (2003) assessing frequency, duration, distance, and beach habits (Score range: 4-20).

Risky Swimming Behaviors Score: Evaluated using a 4-item binary index adapted from Moran (2003) measuring unsafe water habits (Score range: 0-4).

Water Entry/Exit Fall Anxiety: Assessed as a binary response (Yes/No) via Question 9 of the water safety questionnaire.

SECTION 2: STATISTICAL ANALYSIS PLAN (SAP)

2.1 General Statistical Considerations

All quantitative data will be analyzed using IBM SPSS Statistics (Version 24.0 or newer). Descriptive statistics will be presented as mean ± standard deviation (SD), median (interquartile range, IQR), or frequency (%) as appropriate. Normality of continuous variables will be assessed using the Shapiro-Wilk test and visual evaluation of Q-Q plots.

2.2 Primary & Secondary Hypothesis Testing

Due to non-normal distributions or ordinal scale characteristics, non-parametric inferential methods will be applied:

Pre- vs. Post-Intervention Continuous Measures: Changes in 30CST repetitions, Jamar Handgrip Strength (kg), Swimming Behaviors Score, and Risky Swimming Behaviors Score will be evaluated using the Wilcoxon Signed-Rank Test.

Categorical / Binary Outcomes: Proportional shifts in water entry/exit fall anxiety (Yes vs. No) from Baseline to Post-test will be tested using McNemar's Test.

Correlation Analysis: Relationships between physical performance improvements (delta 30CST/Handgrip) and changes in water safety perception scores will be evaluated using Spearman's rank correlation coefficient.

2.3 Significance Level & Missing Data

A two-tailed p-value threshold of alpha = 0.05 will denote statistical significance. Intention-to-treat (ITT) or complete-case analysis will be executed depending on dropout rates, with sensitivity testing performed where appropriate.

SECTION 3: ETHICS & GOVERNANCE

Ethical Approval Details:

This protocol was formally approved by the Eskisehir Technical University Scientific Research and Publication Ethics Committee on January 15, 2025 (Approval Number: E-87914408-050-62641). All procedures adhere to the Declaration of Helsinki and CONSORT guidelines for quasi-experimental designs.